| | Time-Domain | Frequency Domain |
|---|---|---|
| Linearity | $a_1 s_1(t) + a_2 s_2(t)$ | $a_1 S_1(f) + a_2 S_2(f)$ |
| Conjugate Symmetry | $s(t) \in \mathbb{R}$ | $S(f) = S(-f)^*$ |
| Even Symmetry | $s(t) = s(-t)$ | $S(f) = S(-f)$ |
| Odd Symmetry | $s(t) = -(s(-t))$ | $S(f) = -(S(-f))$ |
| Scale Change | $s(at)$ | $\frac{1}{\lvert a\rvert} S\left(\frac{f}{a}\right)$ |
| Time Delay | $s(t-\tau)$ | $e^{-(j2\pi f\tau)} S(f)$ |
| Complex Modulation | $e^{j2\pi f_0 t} s(t)$ | $S(f - f_0)$ |
| Amplitude Modulation by Cosine | $s(t) cos(2\pi f_0 t)$ | $\frac{S(f-f_0) + S(f+f_0)}{2}$ |
| Amplitude Modulation by Sine | $s(t) sin(2\pi f_0 t)$ | $\frac{S(f-f_0) - S(f+f_0)}{2j}$ |
| Differentiation | $\frac{d}{dt} s(t)$ | $j2\pi f S(f)$ |
| Multiplication by $t$ | $\int_{-\infty}^{t} s(\alpha)\, d\alpha$ | $\frac{1}{j2\pi f} S(f) \;\; if \;\; S(0) = 0$ |
| Area | $ts(t)$ | $\frac{1}{-(j2\pi)} \frac{d}{df} S(f)$ |
| Value at Origin | $\int_{-\infty}^{\infty} s(t)\, dt$ | $S(0)$ |
| Parseval"s Theorem | $\int_{-\infty}^{\infty} (\lvert s(t)\rvert)^2\, dt$ | $\int_{-\infty}^{\infty} (\lvert S(f)\rvert)^2\, df$ |

**Table 4.2 Fourier Transform Properties**

# Example 4.5

In communications, a very important operation on a signal s (t) is to **amplitude modulate** it. Using this operation more as an example rather than elaborating the communications aspects here, we want to compute the Fourier transform the spectrum of

$$(1 + s(t))cos(2\pi f_c t)$$

Thus,

$$(1 + s(t))cos(2\pi f_c t) = cos(2\pi f_c t) + s(t)cos(2\pi f_c t)$$